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Instruction Manual

March 1977
REPLACES JULY 1974

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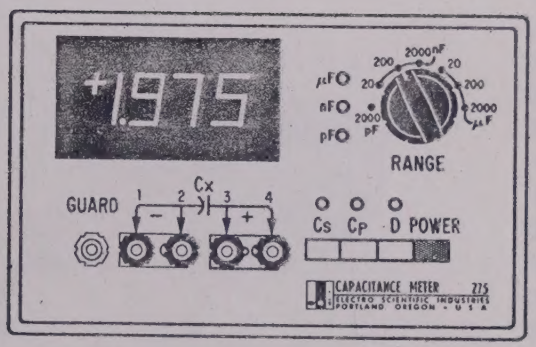
MODEL 275

Digital Capacitance Meter



MP MASTER
MA30732

SERIAL NUMBER _____
PART NUMBER: 26000

esi®
Electro Scientific Industries, Inc.
13900 N.W. SCIENCE PARK DRIVE, PORTLAND, OREGON 97229
TELEPHONE: (503) 641-4141, TELEX: 36-0273

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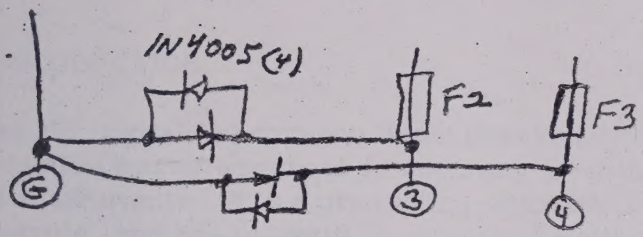
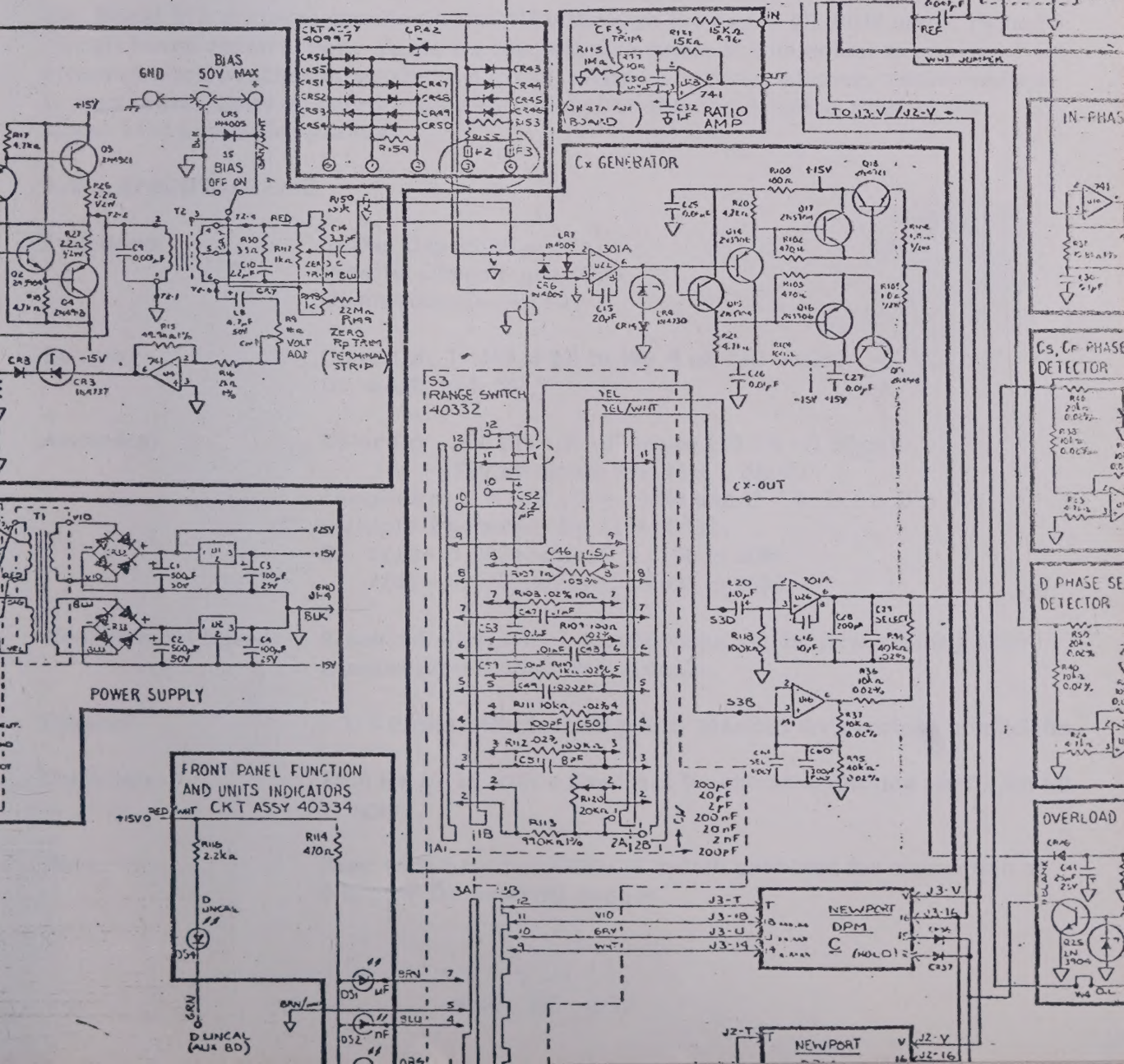
for
TRANCHANT

"Intrinsically Safe"



F2, F3 = 1/4 A



SECTION 1
DESCRIPTION

1.1 INTRODUCTION

ESI Model 275 Digital Capacitance Meter provides extremely rapid automatic capacitance and dissipation measurements at an accuracy level usually reserved for manually-balanced instruments. It is a production-oriented instrument with a minimum of front panel controls, and has brightly illuminated function lights and a 3 1/2 digit high-intensity readout with decimal point. The Model 275 is also designed for use in development laboratories in that it offers a wide range of capacitance and high-resolution dissipation measurements. Provision for a variety of optional features make the instrument truly universal.

The Model 275 achieves excellent reliability through the use of all solid state, etched circuit board construction. Also, its compact size makes it convenient to use on crowded work benches or production areas. With an optional adapter, rackmounting is easy either alone or side-by-side with a similar sized instrument such as the Model 1412 Limits Comparator.

1.2 SPECIFICATIONS

Functions:	Series Capacitance (Cs) Parallel Capacitance (Cp) Dissipation Factor (D)
Ranges:	Cs or Cp: 7; 199.9 pF to 199.9 μF full scale. D: 0.000 to 1.000
Accuracy:	Cs or Cp: 200 pF - 20 μF range ±(0.1% + 1 digit) 200 μF range ±(0.3% + 1 digit) [Applies at T = 23°C, F = 1 kHz and D < 0.1; for D > 0.1 multiply % accuracy by $(1 + 5D^2)$]. D: ±(1% + 0.002) when C = 0100 to 1999 ±(3% + 0.010) when C = 0020 to 0099.
Measurement Speed:	2/second standard; 1 second required for first reading after connecting unknown to terminals.
Display:	3 1/2 digits with decimal point; blanked for overload conditions.
Oscillator:	1000 Hz ±0.1% with a fixed 0.5 V peak ac amplitude for Cx on all ranges.
Bias:	Rear terminals and OFF-ON switch provided for connection of 0 to 50 V DC external supply.

Connection to Unknown:	Unit provided with 4 terminals plus guard on front panel. For comparison and offset measurements, an external capacitor can be connected to two terminals plus ground in rear.
Analog Output:	Proportional to digital value of component at 1 mV/count. (Multiply by $1/\sqrt{1+D^2}$ for high D capacitors.)
Power Requirements:	100 to 125 V or 200 to 250 V, 50 - 60 Hz, 30 W.
Dimensions:	Height 14.5 cm (5.7 in.) with feet; width 21.6 cm (8.5 in.) Depth 36.2 cm (14.25 in.)
Weight:	4.8 kg (10.5 lb).

Model 275 is protected from discharge of capacitors across its terminals by a special circuit. The table below gives the maximum limits of this protection.

$E = \frac{1}{2} CV^2$ joules

5 kV	0 to 0.2 μF	2.5 joules
1 kV	0.2 to 2 μF	1.0 "
500 V	2 to 20 μF	2.5 "
100 V	20 to 200 μF	1.0 "

Two fuses in the circuit should be checked if the instrument does not operate after a charged capacitor is connected to it. Fuses are number AGW 3A or GMA 3A metric, fast acting. The circuit is located on the front terminals and the fuses can be checked by sliding back the bottom panel.

If someone is measuring analog output for C & D, he can see a change (~ 0.1 to 0.3 mV = 0.1 to 0.3 digit) in DVM monitoring. This is inherent to the design & is caused by dc drop across different LED's on front panel.

SECTION 2

OPERATION

2.1 CONTROLS AND CONNECTORS

2.1.1 Front Panel

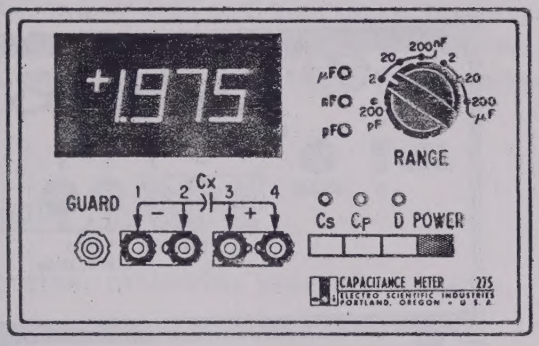
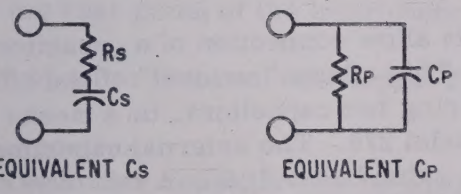


Figure 2-1. Model 275 Front Panel

The RANGE control selects the full-scale range of the meter. A decimal light is selected by this switch, as is one of the units lights (pF, nF or μF). For maximum accuracy, use the lowest range that will permit an on-scale reading.

The Cs and Cp pushbuttons select the type of equivalent capacitor to be measured: series or parallel (see Figure 2-2), where R represents the loss in the capacitor. For capacitors with low dissipation ($D < 0.01$), the equivalent value is essentially the same. When making near-zero readings, Cp should be selected to prevent display lockout. The Cp light will flash as a reminder to use the Cp function for near-zero capacitance values.



$$D = 2\pi f C_S R_S = \frac{R_S}{X_S}$$

$$= \frac{1}{2\pi f C_P R_P} = \frac{X_P}{R_P}$$

Figure 2-2.

The D pushbutton allows measurement of dissipation factor of either circuit, since it is equal for both. D measurement should be made on the same RANGE setting as the capacitance measurement.

The POWER switch is a push-on, push-release button.

The four Cx terminals and the GUARD terminal are spaced to receive a standard ESI cable assembly, such as the KELVIN KLIPS® or Model 1304 Sorting Fixture. The polarity marking on the terminals has significance only when a bias voltage is applied to the rear-panel terminals; the signal on the terminals is a 0.5 V peak sine wave about a zero volt baseline. Connections to Cx 1 and Cx 2 terminals should be shielded when measuring low-value capacitors. The shield should be connected to the guard terminal

2.1.2 Rear Panel

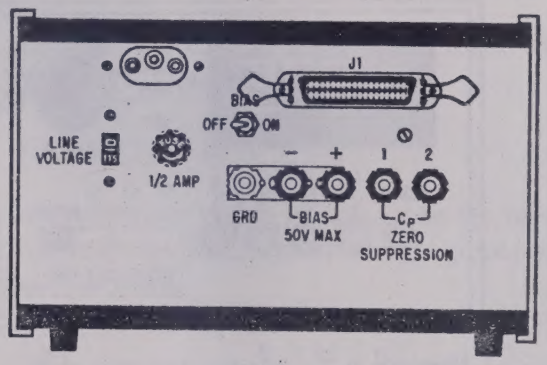


Figure 2-3. Model 275 Rear Panel

The BIAS terminals on the rear panel allow application of a zero-to-50 V bias to the measured capacitor. The bias voltage must be applied in the polarity indicated; a diode protects the Model 275 from wrong-polarity damage but may result in power supply loading. The negative terminal is externally grounded. The bias feature is usually used to measure diode capacitance, or for tantalum or electrolytic capacitors on high ranges.

The BIAS switch allows bias to be conveniently removed without disconnection. A strap between the BIAS terminals assures proper operation should the switch be inadvertently set to ON with no bias connected.

The Cp ZERO SUPPRESSION terminals allow connection of a capacitor that is essentially subtracted from the digital display. This allows "removal" of the effects of lead capacitances, a convenient means of comparing two capacitors, or a means of slightly extending any of the ranges of the Model 275. The external capacitor can be used on the Cp function only and should be a value below 1 μF. A trim control above the terminals allows offsetting the zero capacitance by a few picofarads.

A 36-pin connector on the rear panel is provided primarily to accommodate optional BCD and bridge analog outputs. Unless the instrument contains optional wiring, the only wires connected are common (pin 4), reference V (pin 3), C (pin 1) and D (pin 2). C and D outputs provide about $1/\sqrt{1 + D^2}$ V per 1000 counts on the display.

A LINE VOLTAGE switch selects a nominal input line voltage of 115 V or 230 V.

2.2 OPERATING INSTRUCTIONS

To turn on the unit, simply press the POWER button. This will cause one or more of the front-panel indicating lamps to light.

2.2.1 Measuring Series Capacitance

Press the Cs function button, select a range with the RANGE switch, and connect the unknown capacitor to the terminals as indicated on the front panel. The measurement is displayed after one second or less and repetitive measurements are made at the rate of two per second; one of the three units lights will indicate the readout units (pF, nF or μF). If the capacitance of the unknown exceeds the range selected, the display will remain blanked.

2.2.2 Measuring Parallel Capacitance

Press the Cp function button; otherwise proceed as above.

2.2.3 Measuring Dissipation Factor

With RANGE switch set on the proper range for the unknown capacitor, press the D function button. The display is the dissipation factor of the series equivalent circuit (which is virtually the same as the dissipation factor of the parallel equivalent circuit). If the D value of the unknown capacitor exceeds approximately 1.2, the display will remain blanked.

2.2.4 Using an External Capacitor

An external capacitor can be used only in the Cp mode, and is generally limited to a value less than 1 μF. This capacitor is connected to the Cp ZERO SUPPRESSION terminals on the rear panel of the instrument.

The external capacitor feature of the Model 275 is generally used in one of three ways:

Comparison
An unknown capacitor can be compared with one of a known value. The display will indicate zeros when the capacitors are the same value, or the capacitance difference (+ or -) when they are not.

Test Fixture Compensation
An external trimmer capacitor and/or the provided trimmer can be used to "subtract" the effect of test fixture or other extraneous capacitance. Connect the test fixture to the front panel terminals and adjust the trimmer or the external capacitor for a zero reading on the 200 pF range.

Range Extension

When measuring a capacitor that is slightly beyond the top of one of the ranges, it may be desirable to extend the top of the range with an externa capacitor, rather than change ranges and reduce resolution. This is done in a similar manner to the above; the digital display will go negative by the value of the external capacitor, and this must be borne in mind wh computing the actual value of the unknown.

The maximum capacitance connected to the Cp ZERO SUPPRESSION Termir should not exceed the range selected.

2.2.5 Using the Bias Feature

Rear-panel provision is made for connecting an external bias of zero to 50 volts*. T input is diode-protected to prevent reverse polarity from being applied, and a switc allows removal of the bias without disconnecting it. Remove shorting link between + and - BIAS terminals when using this feature.

Bias voltage is necessary or desirable when measuring the capacitance of electrolyti or tantalum capacitors or of diodes.

With no bias supply connected, the terminals should be strapped together to prevent inoperation if the switch should be inadvertently set to the ON position.

2.2.6 Measuring Grounded Capacitors

Model 275 is designed for measuring ungrounded capacitors. Sometimes, however, one side of a capacitor is connected to earth ground. To measure such a capacitor, remove the ground link between the rear panel BIAS (-) and GND terminals. Then, connect Cx terminals 3 and 4 to the grounded end of the unknown and terminals 1 an 2 to the ungrounded end. Select the proper RANGE and read the value. For low capacitance measurements make a zero-capacitance correction by noting the meter reading with only Cx terminals 3 and 4 connected to the unknown. Subtract this fro the reading for the unknown capacitance.

*If the external bias supply is not a low ac impedance type, it should have a capacitor bypass of five times the range full scale value connected across the bias terminals. The bias supply should be current limited to 1 A maximum.

SECTION 3
CIRCUIT DESCRIPTIONS

3.1 GENERAL DESCRIPTION

A voltage (E_{IN}) is applied to the reference capacitor (C_{REF}) and unknown capacitor (Cx) from the 1 kHz generator. A current proportional to the capacitance value is produced and passes through operational amplifier feedback resistors R_{REF} and R_R. This produces two voltages which can then be compared to analyze the equivalent circuit of Cx.

The parallel capacitance (Cp) is obtained by comparing the value of Cx channel voltage with that of the C_{REF} channel, using the C_{REF} channel as 0° phase reference. A digital ratiometer, which employs the dual slope integration process, is used for this comparison. Refer to Figure 3-1.

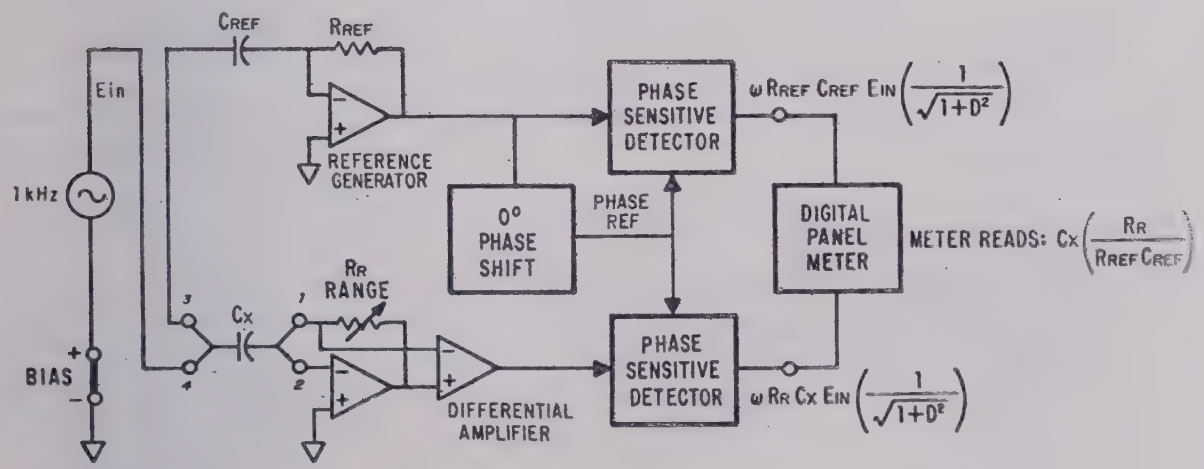


Figure 3-1. Model 275 Simplified Diagram, Cp Function

The series capacitance (Cs) equivalent is obtained by comparing the same two volt
as for Cp, except the Cx channel is used as the 0° phase reference. Refer to Figur

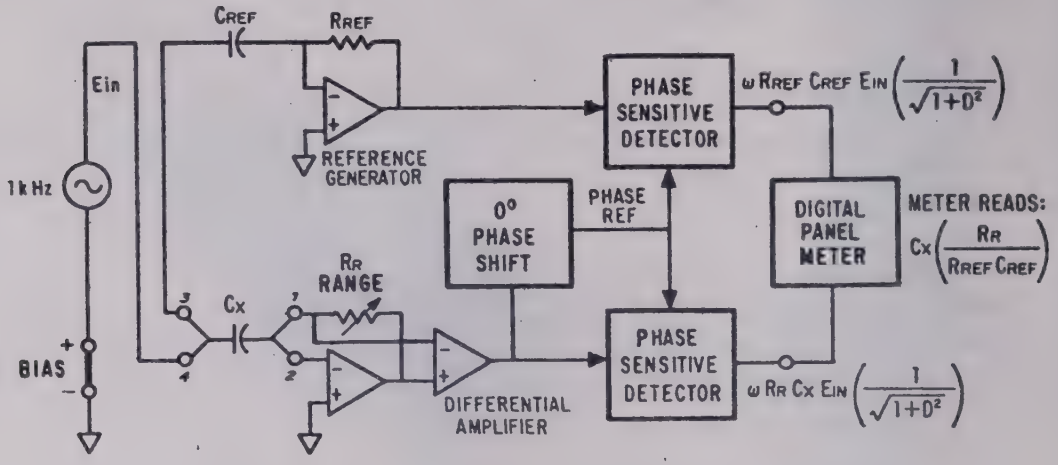


Figure 3-2. Model 275 Simplified Diagram, Cs Function

The dissipation factor (D) is measured by comparing the 90° and 0° voltages of the
channel, using the Cx channel for the 0° phase reference. Refer to Figure 3-3.

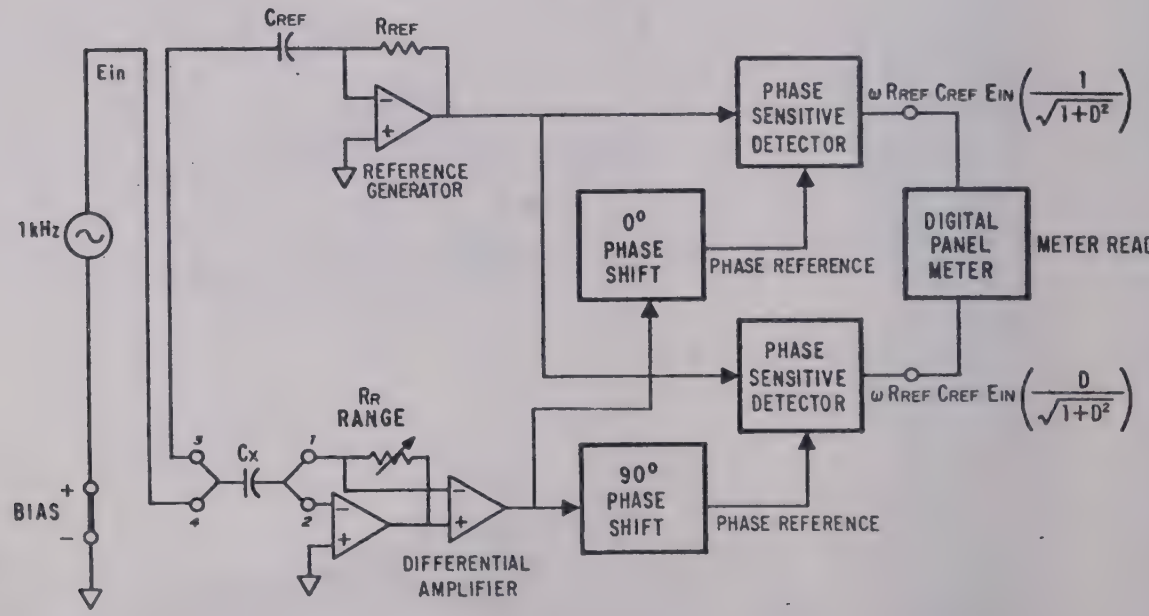


Figure 3-3. Model 275 Simplified Diagram, D Function

3.2 DETAILED CIRCUIT DESCRIPTIONS

3.2.1 1 kHz Oscillator

The 1 kHz signal applied to the unknown and reference capacitor is generated by U3, a Wein Bridge Oscillator, amplified by Q1, Q2, Q3 and Q4, and coupled through T2. U4, Q5 and their associated components comprise a feedback path for regulating amplitude. R1, C5, R7, R8 and C6 determine the oscillator frequency. The secondary of T2 is centertapped; bias, when used, is connected in series with the center tap. One side of T2 secondary feeds the signal to Cx and C_{REF}. The other side supplies a 180° phase-difference signal that can be used to feed a Cp ZERO SUPPRESSION capacitor.

.2.2 Reference Generator

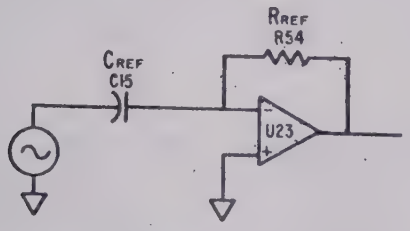


Figure 3-4. Reference Generator Simplified Diagram

he reference generator, U23, is a differentiator whose output is dependent on the equency, ω, the value of the reference capacitor, C15, and the value of the reference sistor, R54. The reference generator tracks the frequency dependent variations of e Cx generator, U22, and prevents small frequency changes affecting the displayed asurements.

3.2.3 Reference Phase-Sensitive Detector

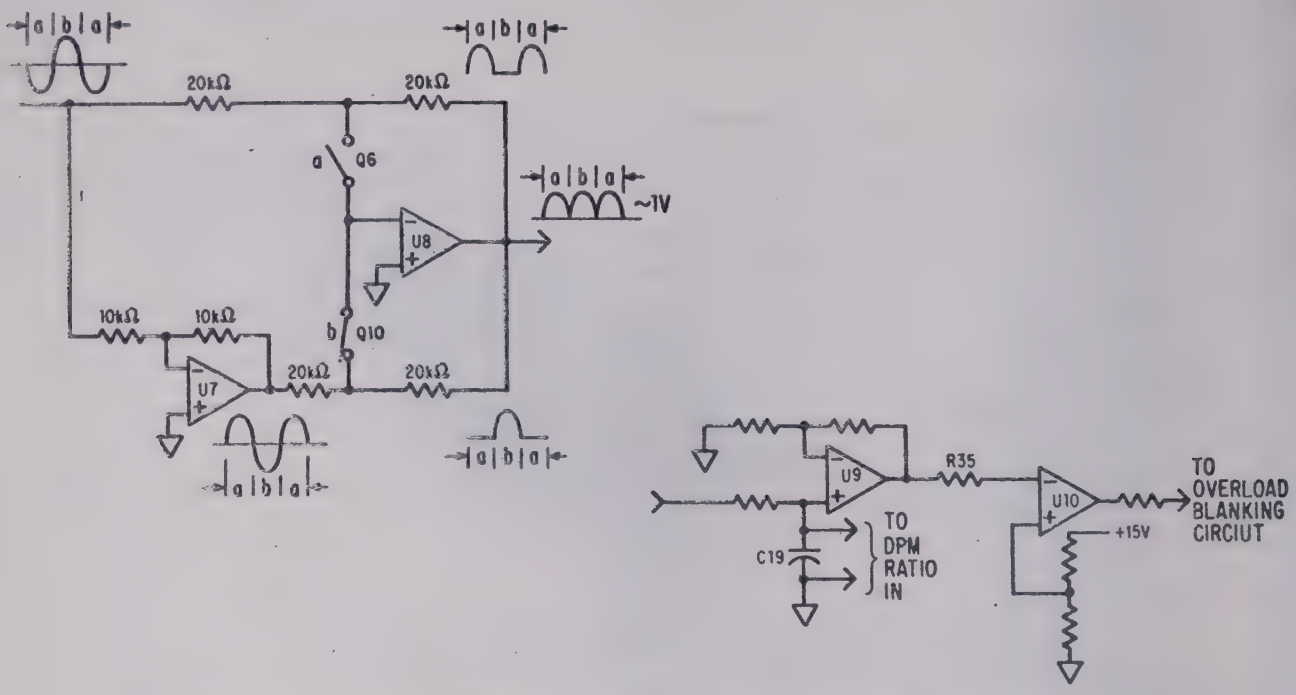


Figure 3-5. Reference Phase-Sensitive Detector Simplified Diagram

The reference phase-sensitive detector provides a reference dc output that is dependent upon the amplitude and phase of the reference generator. The output from the reference generator is gated to the input of the detector, U8, through gating FET's Q6 and Q10. The gating signals to these FET's are supplied by the in-phase generator. The half cycle that is gated through Q10 is inverted by U7. When operating in the Cp mode, the gating signal from the in-phase generator is in-phase with the signal from the reference generator. In this case, the positive half-cycle of the reference generator is gated through Q6 and the negative half-cycle, inverted to positive, is gated through Q10. When the Cs or D modes are used the phase of the reference generator may not match that of the gating FET's since the in-phase generator is synchronized with the phase of the Cx generator. The full-wave output from U8 is filtered and applied to the digital panel meter across C19, which sets the full scale reference level for the dual slope integration process. U9 and U10 function as amplifier and comparator to determine when the voltage across C19 drops to a value where the dpm can no longer make accurate conversons. When this occurs, the output of U10 goes high and triggers the overload blanking circuit causing the dpm to blank.

.4 Quadrature Generator

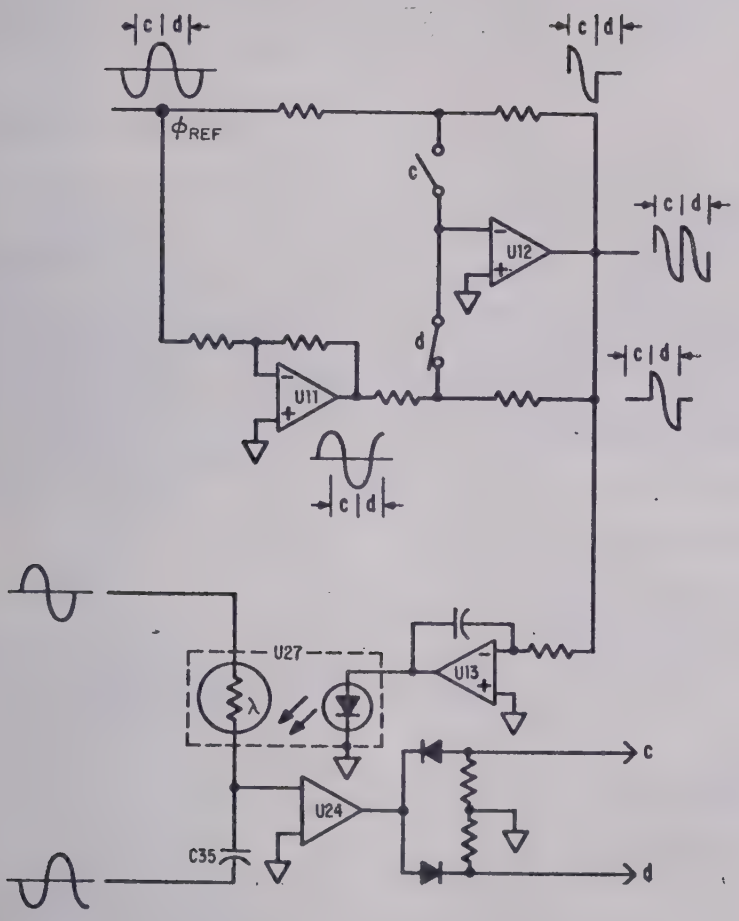


Figure 3-6. Quadrature Generator Simplified Diagram

output of the reference generator, U23, and the inverted output from U7 are fed to a se-shift divider consisting of C35 and a light-sensitive resistor of equal impedance. phase of the input to U24 and U14 is maintained at exactly 90° from the phase of the al at ϕ reference. The outputs of U24, signals c and d, drive gating FET's Q7 and This portion of the quadrature generator operates in a similar manner as the iously-described reference phase-sensitive detector except that, with a 90° phase- ed input, the output of U12 is very close to zero volts. The output of U12 drives which in turn drives an LED. The intensity of the light from the LED varies the tance of the light-sensitive resistor to maintain exactly 90° phase shift at the input 4.

3.2.5 In-Phase Generator

The 90° signal described above also drives U14, a voltage follower whose output drives the network consisting of R87 and C36. A nearly 90° phase shift occurs at C36, which is the input to U15. C38 provides enough compensation to permit adjusting the phase shift to exactly 90°; the output of U25 provides the in-phase gating signals (a and b) to Q6, Q10, Q8 and Q12.

3.2.6 Cx Generator

The Cx Generator is basically the same as the reference generator described above. The main difference is that, on the higher ranges, more power is demanded because of the small value of range resistor. U22 is the actual Cx generator; Q14, Q15, Q16, Q17, Q18, Q19 and their associated components comprise a power amplifier to drive the range resistor which is in the feedback loop. The output of the Cx generator is taken from U16 and U26, which act as a differential amplifier connected across the range resistor, thereby eliminating effects of lead resistance between Cx and R_R.

3.2.7 Cs, Cp Phase-Sensitive Detector

This detector operates in a similar manner as the reference phase-sensitive detector. Its input from the Cx generator is gated by the in-phase gating signals a and b; its output is fed to the digital panel meter when the Cs or Cp mode is selected.

3.2.8 D Phase-Sensitive Detector

This detector is virtually identical to the Cs, Cp detector above. Its input is from the reference generator (inverted by U7) in the Cs or D modes, or from the Cx generator in the Cp mode. Its output is fed to the digital panel meter when the D mode is selected.

3.2.9 Overload Blanking Circuit

When an overload condition occurs, the output of comparator U21 rises which causes the panel meter digits to blank. Two inputs are connected to the plus side of U21, sampling the outputs of the Cs, Cp and the D phase-sensitive detectors. Another input is connected to R35 which acts as a monitor in the voltage level at Ratio In as discussed in Section 3.2.3. A fourth input is connected to the minus side of U21 through CR26 and CR30 to monitor the dc level of the Cx generator output for biased measurements. Transistor Q25 acts to invert the output of U21 making it compatible with the requirements of the digital panel meter.

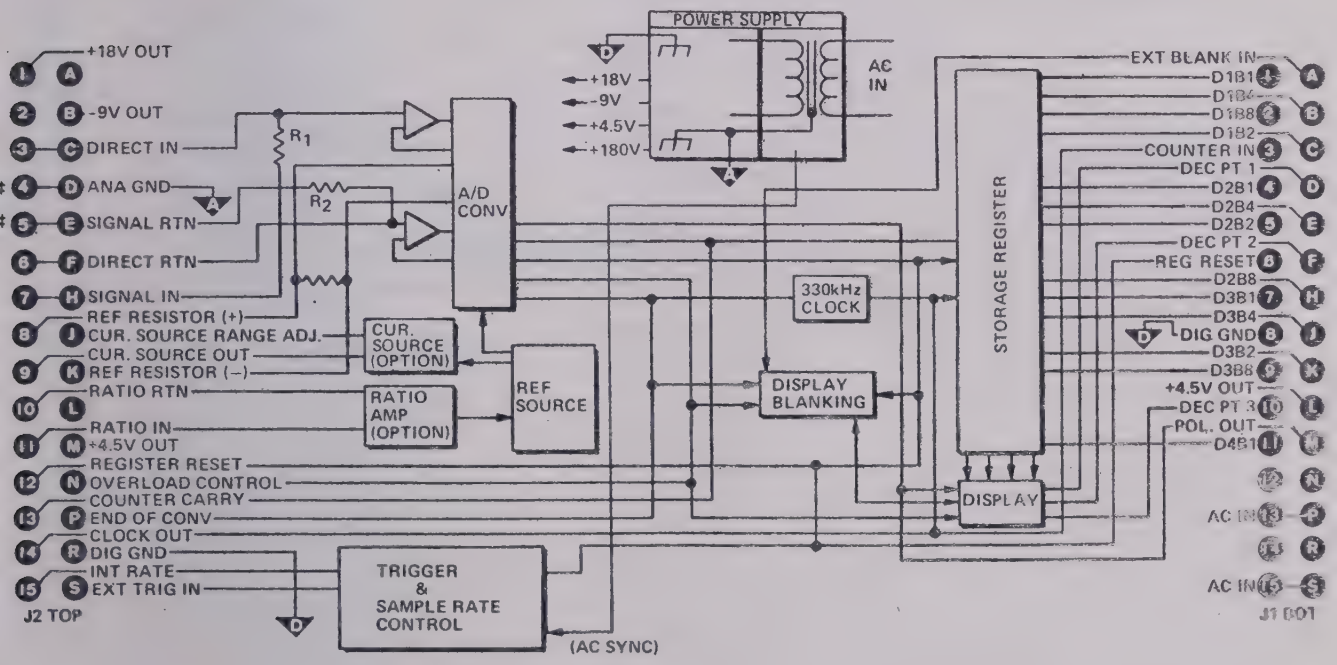
3.2.10 "Use Cp" Lamp Flasher

When the output of the Cs, Cp phase-sensitive detector is below approximately +6 mV, comparator U5 is turned off. This allows multivibrator U6 to operate at about a 2-Hz rate. If, at the same time, the Cs or D mode was selected, the Cp mode lamp will flash, alerting the operator to use the Cp mode for best measurement accuracy.

3.2.11 Digital Panel Meter*

The digital panel meter displays a digital readout proportional to the dc analog voltage presented to its input terminals. The conversion factor is 1000 counts per 1 V input per 1 V reference.

In the conversion process, the analog signal is applied to a balanced differential input amplifier with high input impedance. The A/D converter uses a dual-slope process in which a current proportional to the input is fed to an integrator through a switch closed for a time determined by counting clock pulses in a digital register/counter. At the end of this period the integrator is switched to a reverse current proportional to the reference source. The register begins counting clock pulses again from zero.



‡These terminals must be system connected so that no more than 3.5V difference of potential exists between them.

Figure 3-7. Functional Block Diagram and Terminal Designations*

*See footnote on page 3-8.

The upward ramp of the integrator waveform of the timing diagram (see Figure 3-8) describes this phase of the conversion. The magnitude of the reference current is set by the voltage at Ratio In at a value corresponding to full scale analog input; therefore, for a full scale input, the count will reach 100% of full scale just as the integrator returns to its initial conditions. If the input is lower, the integrator will return soon registering a corresponding lower count.

Refer to Figure 3-7 for a functional block diagram and terminal designations of the digital panel meter. Refer to Figure 3-8 for a timing diagram and associated waveform

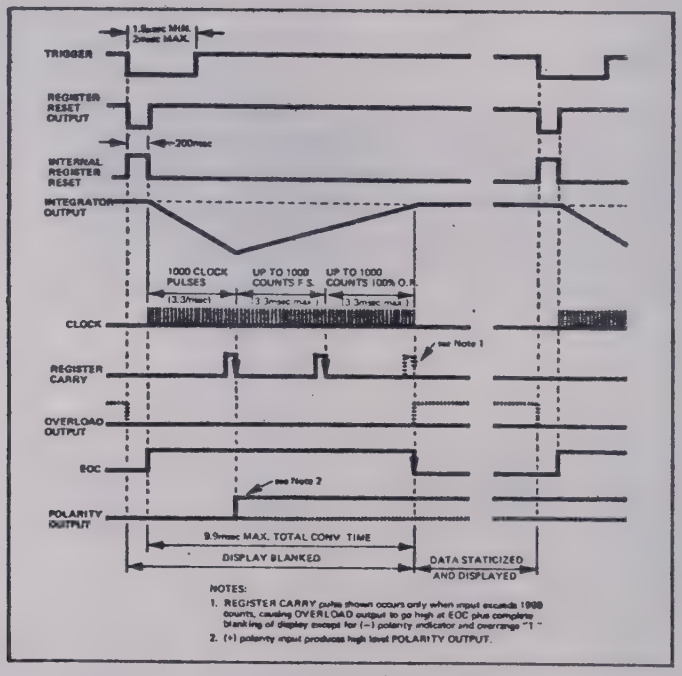


Figure 3-8. Timing Diagram and Waveforms*

*Sections 3.2.11 and 3.4 and Table 3-9 Copyright© by Analogic Corporation, used by permission. Due to the proprietary nature of the information, no rights to duplicate or use it are granted except for supporting installation, operation or maintenance of the equipment.

3.3 DIGITAL PANEL METER BCD OUTPUT

A BCD output of the Analogic AN2532 digital panel meter reading is available at the lower pin connector on the back of the panel meter. The pin assignments for this output are shown in Figure 3-7. Refer to Table 3-9 for general specifications on this feature.

Table 3-9. Digital Panel Meter Digital Input and Output Specifications*

DIGITAL CONTROL INPUTS (See Timing Diagram)	Logic	DTL/T^2L, present loads of 1.6 mA@ lower level and 10 µA@ upper level
	External Trigger	DC coupled
	External Blanking	Low level blanks 3 least significant display digits
	Sample Rate { *Int. Control*	Preset Repetitive
	Sample Rate { *Ext. Control*	Variable Repetitive, or Hold and Read (See also Section 3.4)
DIGITAL OUTPUTS (See Timing Diagram)	Logic	DTL/T^2L, sinks 5mA@ lower level and sources 100 µA @ upper level
	BCD Data	3 BCD digits (8-4-2-1), plus "1" overrange (13 lines, 1 load each)
	Polarity	(+) input produces high level at EOC
	Overload (> 1999 counts)	Output level is high
	Register Reset	Inverse of Trigger pulse
	End of Conversion	Goes high at Trigger; transition from High to Low is EOC (5 loads)
	Clock (Internal Trigger)	330 kHz nominal

*See footnote on page 3-8.

3.4 DIGITAL PANEL METER TRIGGER COMMANDS*

The digital panel meter normally provides two conversions per second for maximu useful visual display. If desired, the unit may be externally triggered to provide much higher speeds for data linkage applications. Similarly, the display may be externally triggered to hold the last reading until triggered again to indicate the value of a new measurement (Hold and Read).

3.4.1 External Trigger

Up to 100 conversions per second may be made by using external triggering as shown in Figure 3-10 (A). Upon transition from upper to lower level, the unit resets. Minimum reset time (and therefore, minimum duration of lower level) is 1.5 μs. A new conversion will commence on the rising edge of the trigger signal which must then remain at upper level for duration of conversion.

3.4.2 Hold and Read

Hold and Read operation may be provided with the external circuit configuration of Figure 3-10 (B).

3.4.3 Internal Sample Rate Adjustment

The Internal Sample Rate may be varied by externally adjusting the internal circuit as shown in Figure 3-10 (C). To change from the normal measurement speed of two per second, do one of the following:

1. To increase, add resistance externally between J2 pins 1 and 15.

2. To decrease, add capacitance externally between J2 pins 15 and R.

Measurement speed will be determined by the formula:

$$\text{Speed} = 0.7\ RC \text{ seconds per measurement} = 0.5 \text{ second (normal)}$$

where $R = 1.0\ M\Omega$ (permanently wired internally across the DPM pins)

$C = 0.68\ \mu F$ (permanently wired internally across the DPM pins)

For example, adding a 1.0 MΩ resistor (in parallel) will double the normal speed of two measurements per second. Adding a 0.68 μF capacitor (in parallel) will halve the normal speed.

*See footnote on page 3-8.

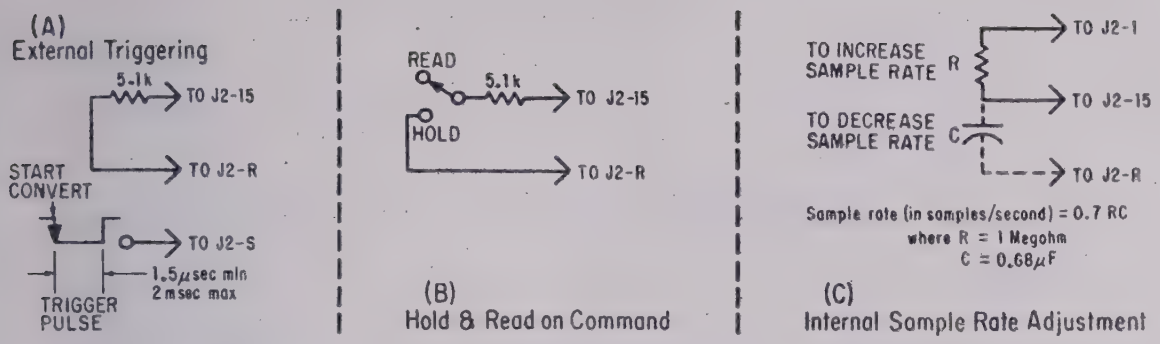


Figure 3-10. Conversion Rate Control Methods*

*See footnote on page 3-8.

SECTION 4
MAINTENANCE

4.1 CALIBRATION PROCEDURE

Equipment Required	Minimum Specifications
Frequency counter	Measure 1 kHz with resolution of 0.2 Hz
Digital voltmeter	Resolution 100 μV dc volts and 1 mV ac volts
Oscilloscope	1 MHz resolution bandwidth, 50 mV/div
Standard capacitors	0.1 μF & 100 pF calibrated to ±0.05% with D < 0.0005
Resistors	180 Ω 5% and 1592 Ω 0.1%
Capacitor	1000 pF with D < 0.0005

Refer to Figure 4-3 for adjustment locations.

1. POWER SUPPLY. Setup - All binding post terminal links in place, top cover removed, instrument turned on. Allow a 30 minute warm up period. Check - power supply voltages at C3 and C4. They should be + and -15 V ±5% (14.25 to 15.75 V).

2. OSCILLATOR ADJUSTMENT. Setup - Connect oscilloscope probe to the junction of R2 and Q5. Connect frequency counter and digital voltmeter between Cx terminal 4 and GUARD, which is grounded via the rear-panel link. Adjustment - Adjust R13 for 200 mV p-p on oscilloscope. Adjust R9 for 354 mV rms on multimeter. Final adjustment of R9 will be done in a later step. Adjust R8 for 1 kHz ±0.2 Hz on counter. These adjustments interact; repeat the above procedures.

3. Remove the above setup. With the oscilloscope, check for 8 V ±1 V p-p at the junction of R26 and R27.

4. OP AMP U18 ZERO TRIM. Setup - Press the Cp button and set the RANGE switch to 200 nF. Connect the digital voltmeter high lead to pin 1 and the low lead to pin 4 of J1, the rear-panel connector. Adjustment - Adjust R62 for 0 volts ±0.0003 V.

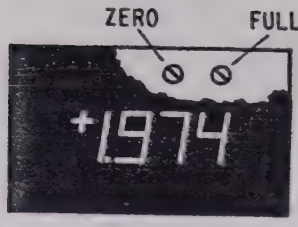


Figure 4-1. Location of Digital Panel Meter Adjustments (Light Filter Removed)

5. DIGITAL PANEL METER ZERO TRIM. Setup - Same as above. Adjustment - If the panel meter does not read 00.0, adjust the trimmer on the front of the meter (see Figure 4-1).

6. OP-AMP U20 ZERO TRIM. Setup - Same as step 4 except connect the digital voltmeter high lead to pin 2 of J1. Adjustment - Adjust R63 for 0 volts ±0.0003 V.

7. REFERENCE VOLTAGE. Setup - Connect the digital voltmeter between ground and either end of R106. Check - The dvm should read 1 volt ±0.1 V. The reference voltage will be adjusted later.

8. OP AMP U8 ZERO TRIM. Setup - Ground junction of R33 and R34. Remove the shorting strap between Cx terminals 3 and 4 (leave the strap between terminals 1 and 2 in place). Connect a 0.1 μF capacitor with a D less than 0.0005 between Cx terminals 2 and 3. Connect a 180 Ω resistor with a series switch between Cx terminal 3 and the GUARD terminal. Adjustment - Alternately switch the 180 Ω resistor in and out of the circuit and adjust R60 for a constant reading on the digital panel meter (the exact reading is unimportant at this time). Remove the setup and replace the strap between Cx terminals 3 and 4.

9. OUTPUT VOLTAGE. Setup - Reconnect the capacitor used in step 8 to Cx terminal 2 and 3. Connect the digital voltmeter high lead to pin 1 and low lead to pin 4 of rear-panel connector J1. Adjustment - Adjust R9 for 1 V ±0.002 V on the digital voltmeter.

10. REFERENCE VOLTAGE. Setup - Same as step 9 except move the high lead of the digital voltmeter to pin 3 of rear panel connector J1. Adjustment - Set R58 for +6.2 V ±0.01 V on the digital voltmeter. Remove the setup.

11. DPM FULL SCALE. Setup - Press the Cs button and set the RANGE switch to 200 nF. Connect a standard 0.1 μF capacitor to the Cx terminals. Adjustment - Adjust the full scale trimmer on the digital panel meter (see Figure 4-1) for a dpm reading to match the standard.

D ADJUSTMENT

12. Setup - Press the D button and set the RANGE switch to 200 nF. Connect a 0.1 μF standard capacitor to Cx terminals 2 and 3, and note the dpm reading. Adjustment - Change the RANGE switch to 2 μF and adjust R61 for the same dpm reading noted above.

13. Setup - Change the RANGE switch to 200 nF. Adjustment - Adjust C29 for a reading of .000 on the dpm. Repeat steps 12 and 13 making certain that the dpm reads .000 for both the 2 μF and 200 nF range settings.

14. Setup - Press the Cs button. Add a 1592 Ω resistor in series with one of the leads to the standard capacitor. Adjustment - Adjust C38 for a reading of 100.0 on the dpm. These adjustments interact; repeat steps 12 through 14.

15. 200 pF RANGE ZERO TRIM. Setup - Press the Cp button and set the RANGE switch to 200 pF. Connect a 100 pF standard capacitor to the Cx terminals, using shielded leads. Figure 4-2 shows the configuration used at the factory. Adjustment - Disconnect one lead as indicated in Figure 4-2, and adjust the rear panel ZERO TRIM potentiometer for a reading of 00.0 on the dpm.

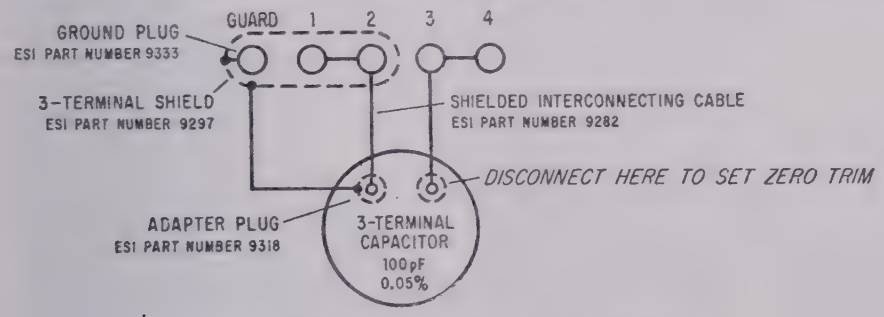


Figure 4-2. 200 pF Range Setup

16. 200 pF RANGE D ADJUSTMENT. Setup - Same as step 15 except reconnect the standard capacitor and press the D button. Adjustment - Set C30 for a reading of .000 on the digital panel meter. On early instruments C30 is located on the circuit board; on later instruments it is located on the RANGE switch as shown in Figure 5-3.

17. 200 pF RANGE TRIM (Instruments above Serial No. 330000 only). Setup - Same as step 16 except press the Cs button. Adjustment - Adjust the trimmer resistor, R120, on the RANGE switch for a reading of 100 pF on the dpm.

18. 2 nF RANGE D ADJUSTMENT. Setup - Same as step 16 except substitute a 1000 pF low loss capacitor ($D < 0.0005$) in place of the 100 pF standard capacitor and set RANGE switch to 2 nF. Adjustment - Set C51 for a reading of .000 on the digital panel meter. C51 is located on the RANGE switch.

19. FINAL CHECK. Measure the values (both C and D) of standard capacitors at several points within each range of the Model 275.

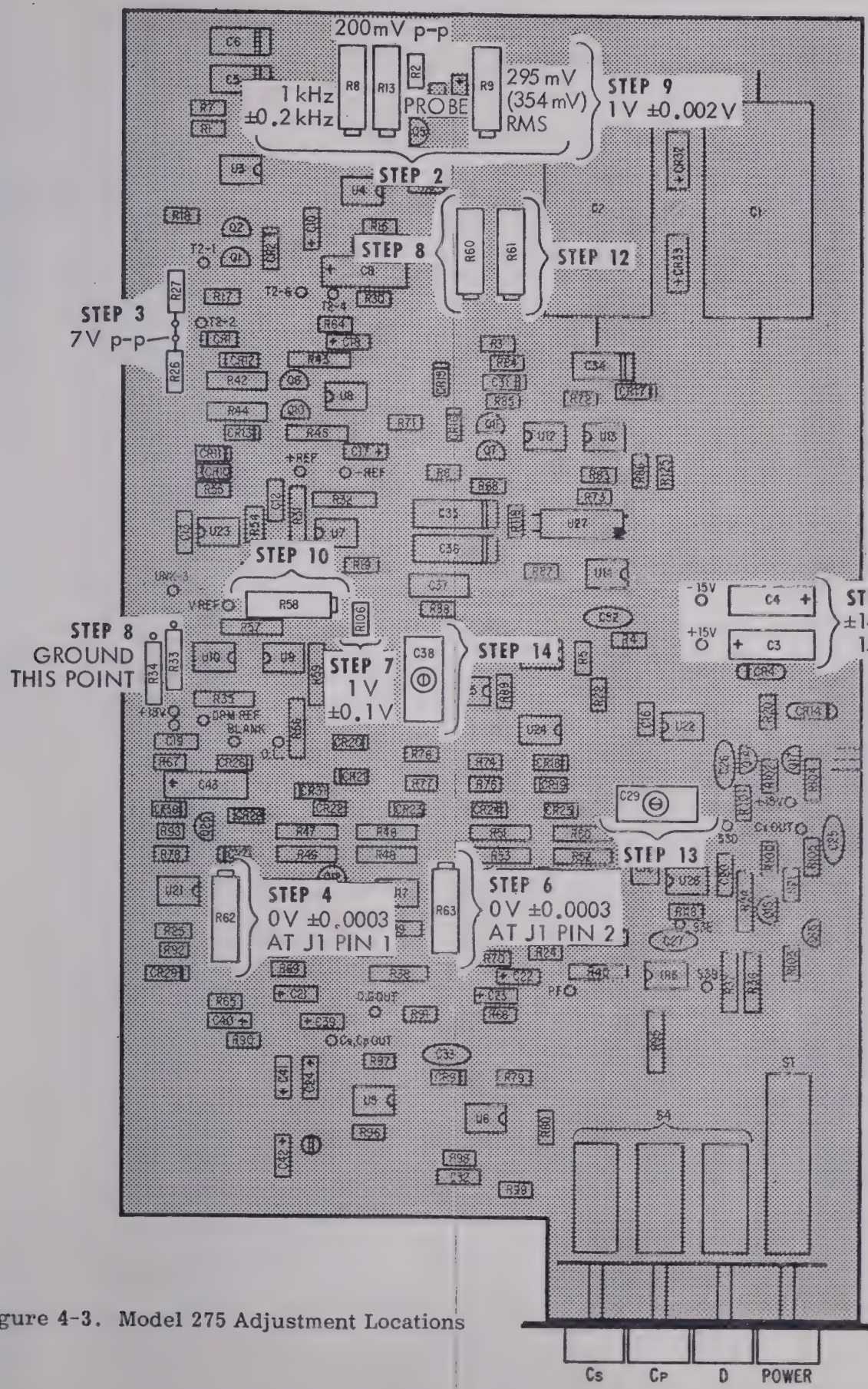


Figure 4-3. Model 275 Adjustment Locations

SECTION 5

PARTS LISTS AND DIAGRAMS

MAINFRAME PARTS

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
A3	Digital Panel Meter, Analogic 2532	337-26017
C9	Capacitor, Disc 0.001 μF	311-21215
C14	Capacitor, Poly, 10.0 pF	313-20210
CR5	Diode, 1N4005	321-01779
F1	Fuse, 1/2 Amp, 3 AG	333-01802
FL1	Filter, Receptable 2B4	504-20282
J1	Connector, 36 Pin	504-15739
J2, J3	Connector, 30 Pin	504-12243
P1	Plug	504-15738
Q3, Q18	Transistor, 2N4921	321-18752
Q4, Q19	Transistor, 2N4918	321-18753
R28, R29	Resistor, 100 Ω, 1/4 W	307-13907
R117	Potentiometer, 1.0 kΩ	306-25966
R121-R123	Resistor, 150 kΩ, 1/4 W, 10% (on J3)	307-13947
S2	Switch, 115/230	330-18424
S3	Switch, Assy, RANGE	230-25960
S5	Switch, S.P.D.T.	330-18769
T1	Transformer, Power	340-20135
T2	Transformer, Isolation	340-25911
U1, U2	Power Supply Regulators UGH 7815393	343-27816
	Bail	336-13174
	Bezel	710-26031
	Binding Post	112-01435
	Cap, Black	112-01170
	Cap, Gold	112-01172
	Cover, Side	711-26030
	Cover, Top	711-26032
	Cover, Bottom	711-26033
	Feet	710-08715
	Fuse Post	334-03074
	Heat Sink	710-26022
	Knob, Black	110-01266
	Line Cord	520-13178
	Panel, Back	720-25915
	Panel, Front	708-26018
	PC Connector Key (Amphenol)	504-25962
	Swing Lug	140-03247

MAIN CIRCUIT BOARD ASSEMBLY A1 (PART NO. 25913)

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
C1, C2	Capacitor, Electrolytic, 500 µF, 50 V	314-01942
C3, C4	Capacitor, Electrolytic, 100 µF, 25 V	314-13683
C5, C6	Capacitor, 0.0159 µF, 1%	313-18845
C7	Capacitor, Tantalum, 6.8 µF, 35 V	314-25339
C8	Capacitor, Tantalum, 4.7 µF, 50 V	314-25965
C10, C39-C42	Capacitor, Tantalum, 2.2 µF, 20 V	314-13283
C11	Capacitor, Silver Mica, 0.01 µF, 1%	312-01929
C12, C28, C56	Capacitor, Poly, 200.0 pF	313-24354
C13, C16	Capacitor, Poly, 10.0 pF	313-20210
C15	Capacitor, 20 pF, Poly	313-20926
C17-C24	Capacitor, Tantalum, 1.0 µF, 35 V	314-06472
C25, C26, C27	Capacitor, Disc, 0.01 µF	311-12144
C29	Capacitor, Trimmer, 14 to 150 pF	316-02166
C31, C32	Capacitor, 0.0022 µF, 10%	313-12399
C33	Capacitor, Disc, 0.1 µF	311-24395
C34, C35	Capacitor, 0.047 µF, 10%	313-01776
C36	Capacitor, 0.1 µF, 10%	313-06470
C37	Capacitor, Poly, 560 pF	313-25922
C38	Capacitor, Trimmer ARCO 429, 90 to 400 pF	316-20352
C43	Capacitor, Electrolytic, 25.0 µF, 25 V	314-01941
C52	Capacitor, Disc, 0.001 µF	311-21215
C55	Selected	
CR1, CR2	Diode, Zener, 1N4744, 15 V	321-12090
CR3	Diode, Zener, 1N4737A, 7.5 V	321-12353
CR4	Diode, Zener, 1N4730A, 3.9 V	321-20144
CR8-CR28, CR31	Diode, 1N914	321-12356
CR29	Diode, Zener, 1N4732A, 4.7 V	321-12449
CR30	Diode, Zener, 1N5230A, 4.7 V	322-41164
CR32, CR33	Rectifier, Bridge, KBP-02 (MDA942A-2)	321-21236
Q1, Q14, Q16	Transistor 2N3906	321-18754
Q2, Q15, Q17, Q25	Transistor, 2N3904	321-18751
Q5, Q10-Q13	Transistor, 2N5459	321-19183
Q6-Q9	Transistor, 2N5462	321-20143
R1-R6, R33	Resistor, 10.0 kΩ, 1/8 W, 1%	305-21740
R7	Resistor, 9.53 kΩ, 1/8 W, 1%	305-21762
R8, R9	Potentiometer, 1.0 kΩ	306-18469
R10	Resistor, 2.49 kΩ, 1/8 W, 1%	305-21734
R11, R93	Resistor, 4.02 kΩ, 1/8 W, 1%	305-21736
R12	Resistor, 8.06 kΩ, 1/8 W, 1%	305-21739
R13	Potentiometer, 5.0 kΩ	306-12092
R14, R55	Resistor, 47 kΩ, 1/4 W	307-13941
R15	Resistor, 49.9 kΩ, 1/8 W, 1%	305-21747
R16	Resistor, 2.0 kΩ, 1/8 W, 1%	305-21733

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
R17-R25	Resistor, 4.7 kΩ, 1/4 W	307-13927
R26, R27	Resistor, 2.2 Ω, 1/2 W	304-25956
R30	Resistor, 3.3 Ω, 1/4 W	307-13888
R31, R32, R36-R41	Resistor, 10.0 kΩ, 0.02%	240-25944
R34	Resistor, 3.65 kΩ, 1/8 W, 1%	305-21223
R35	Resistor, 33 kΩ, 1/4 W, 10%	307-13939
R42-R53	Resistor, 20 kΩ, 0.02%	240-23647
R54	Resistor, 50.0 kΩ, 0.02%	240-25946
R56	Resistor, 1000.0 Ω, 0.02%	240-25951
R57,R71-R78,R80-R82	Resistor, 10 kΩ, 1/4 W, 10%	307-13933
R58	Potentiometer, 500 Ω	306-12093
R59	Resistor, 5.0 kΩ, 0.02%	240-25942
R60-R63	Potentiometer, 10.0 kΩ	306-20145
R64-R67, R99	Resistor, 1.0 kΩ, 1/4 W	307-13920
R68-R70	Resistor, 68 Ω, 1/4 W	307-13902
R79	Resistor, 68 kΩ, 1/4 W	307-13942
R83	Resistor, 6.8 kΩ, 1/4 W	307-13930
R84, R85	Resistor, 20.0 kΩ, 1/8 W, 1%	305-21743
R86	Resistor, 8.2 kΩ, 1/4 W	307-13932
R87	Resistor, 15.8 kΩ, 1/8 W, 1%	305-21742
R88	Resistor, 31.6 kΩ, 1/8 W, 1%	305-21745
R89, R102, R103	Resistor, 470 Ω, 1/4 W	307-13915
R90	Resistor, 1.5 kΩ, 0.05%, ESI QB	240-20999
R91, R106	Resistor, 1.5 kΩ, 1/4 W	307-13922
R92	Resistor, 24.9 kΩ, 1/8 W, 1%	305-21744
R94, R95	Resistor, 40.0 kΩ, 0.02%	240-25945
R96	Resistor, 15 kΩ, 1/4 W	307-13935
R97	Resistor, 5.6 Ω, 1/4 W	307-13891
R98	Resistor, 3.3 MΩ, 1/4 W	307-13966
R100, R101	Resistor, 100 Ω, 1/4 W	307-13907
R104, R105	Resistor, 1.0 Ω, 1/2 W	304-12448
R118	Resistor, 100 kΩ, 1/4 W	307-13945
R119	Resistor, 1 MΩ, 1/4 W, 10%	307-13960
R125	Selected	
S1, S4	Switch, Mode and POWER	330-25919
U3-U21	Operational Amplifier, 741	343-20668
U22-U26	Operational Amplifier, 301A	343-20669
U27	LED Photo Isolator 327-25940	
	PC Board	505-25912A
	Split Lug	503-09427

FUNCTION AND UNITS INDICATORS BOARD ASSEMBLY A2 (PART NO. 25955)

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
DS1-DS6	Lamps, Pilot, LED	336-26021
R114-R116	Resistor, 470 Ω, 1/4 W	307-13915
	PC Board	505-25954

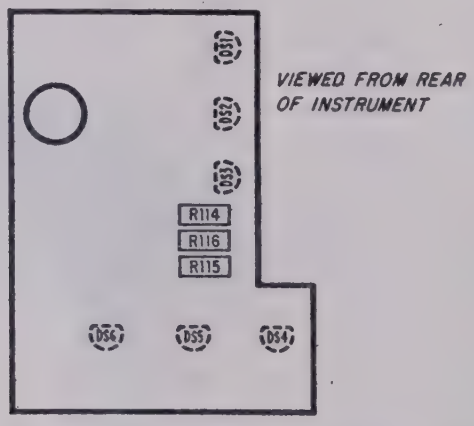


Figure 5-1. Function and Units Indicators Circuit Board Components Locations (Schematic Included in Figure 5-4)

RANGE SWITCH ASSEMBLY A4 (PART NO. 25960)

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
C30, C51	Capacitor, Trimmer, 0.9 pF to 7 pF	316-20353
C44, C45	Capacitor, Disc, 0.01 μF	311-12144
C46	Capacitor, 1.5 μF, 10%	313-25959
C47	Capacitor, 0.1 μF, 10%	313-06470
C48	Capacitor, 0.01 μF, 10%	313-12260
C49	Capacitor, Poly, 1000 pF	313-07094
C50	Capacitor, Poly, 100 pF	313-18760
C53	Capacitor, Disc, 0.1 μF	311-24395
C54	Capacitor, Tantalum, 2.2 μF, 20 V	314-13283
R107	Resistor, 1.0 Ω, 0.05%	240-25948
R108	Resistor, 10.0 Ω, 0.02%	240-25949
R109	Resistor, 100.0 Ω, 0.02%	240-25950
R110	Resistor, 1.0 kΩ, 0.02%	240-25951
R111	Resistor, 10.0 kΩ, 0.02%	240-25944
R112	Resistor, 100.0 kΩ, 0.02%	240-25947
R113	Resistor, 990 kΩ, 1%	305-02001
R120	Potentiometer, 20 kΩ, 10 Turn	306-21199
S3	Switch, 7 Position	201-25715

(Schematic diagram is included in Figure 5-4)

DISCHARGE PROTECTION CIRCUIT ASSEMBLY (PART NO. 40997)

CIRCUIT NO.	DESCRIPTION	ESI PART NO.
CR42	Varistor, GE MOV-Type V68ZA10	327-40993
CR43-CR56	Diode, 1N4005	321-01779
F2, F3	Fuse, 3A, Fast Acting*	333-41003
R153, R154	Resistor, 100 Ω, 1/2 W, 10%	304-01977
R155	Resistor, 0.33 Ω, 2W, 5%	303-13711
	Fuse Clip	334-23949
	PCB, Discharge Protection Circuit	505-40996

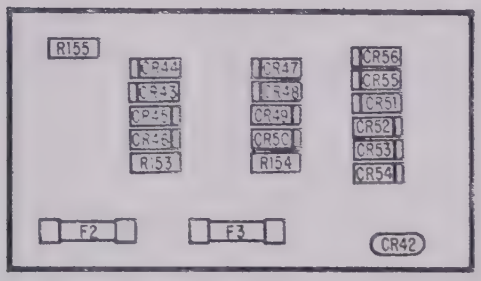
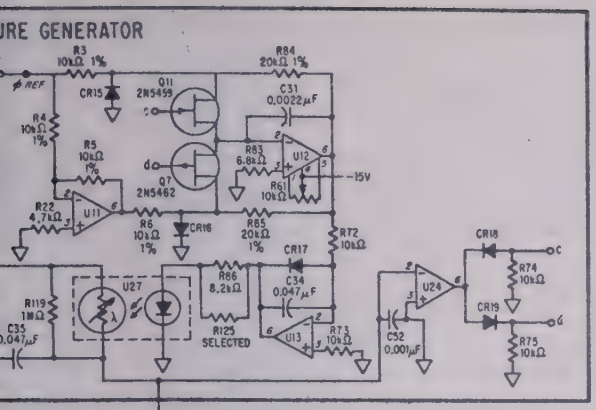
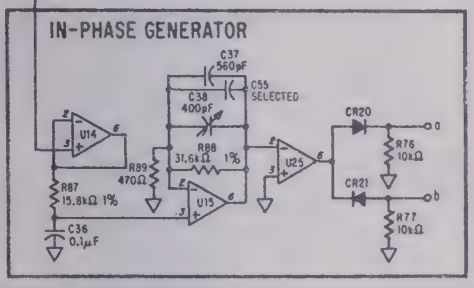


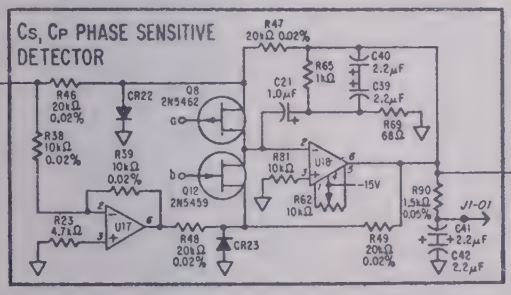
Figure 5-2. Discharge Protection Circuit Board Components Locations (Schematic Included in Figure 5-4)

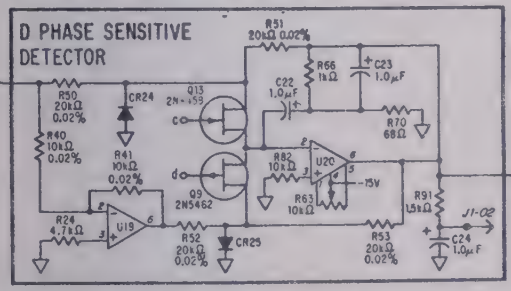
*AGW 3A or GMA metric

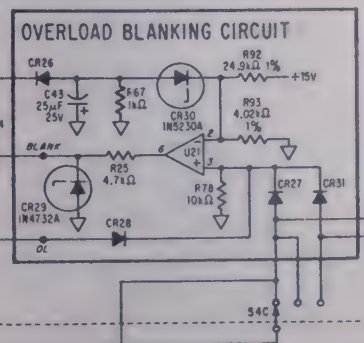
ically Safe"







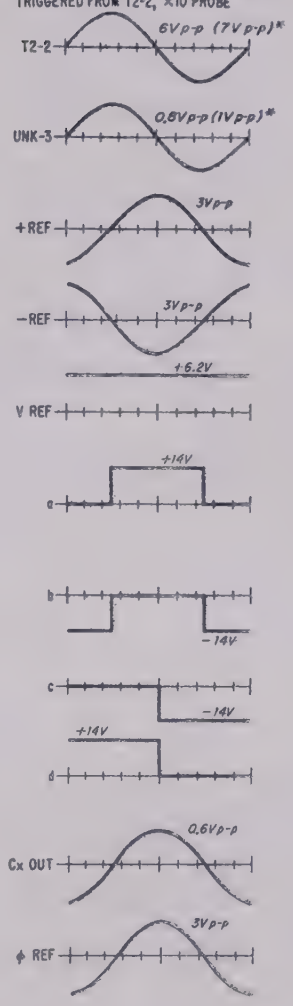


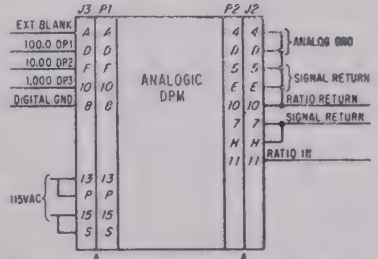


S4C

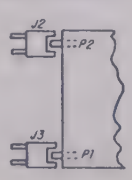
MEASUREMENT CONDITIONS:

Cs MODE
200nF RANGE
Cx = 100nF, D<0.001
0.83ms/DIV (1ms/DIV)* TIME BASE,
TRIGGERED FROM T2-2, ×10 PROBE





POLARIZING KEYS (PN 25962) BETWEEN P1-12 AND P1-13, P1-14 AND P1-15, P2-2 AND P2-3, P2-7 AND P2-8. CONNECTOR (PN 12243) J2 AND J3.



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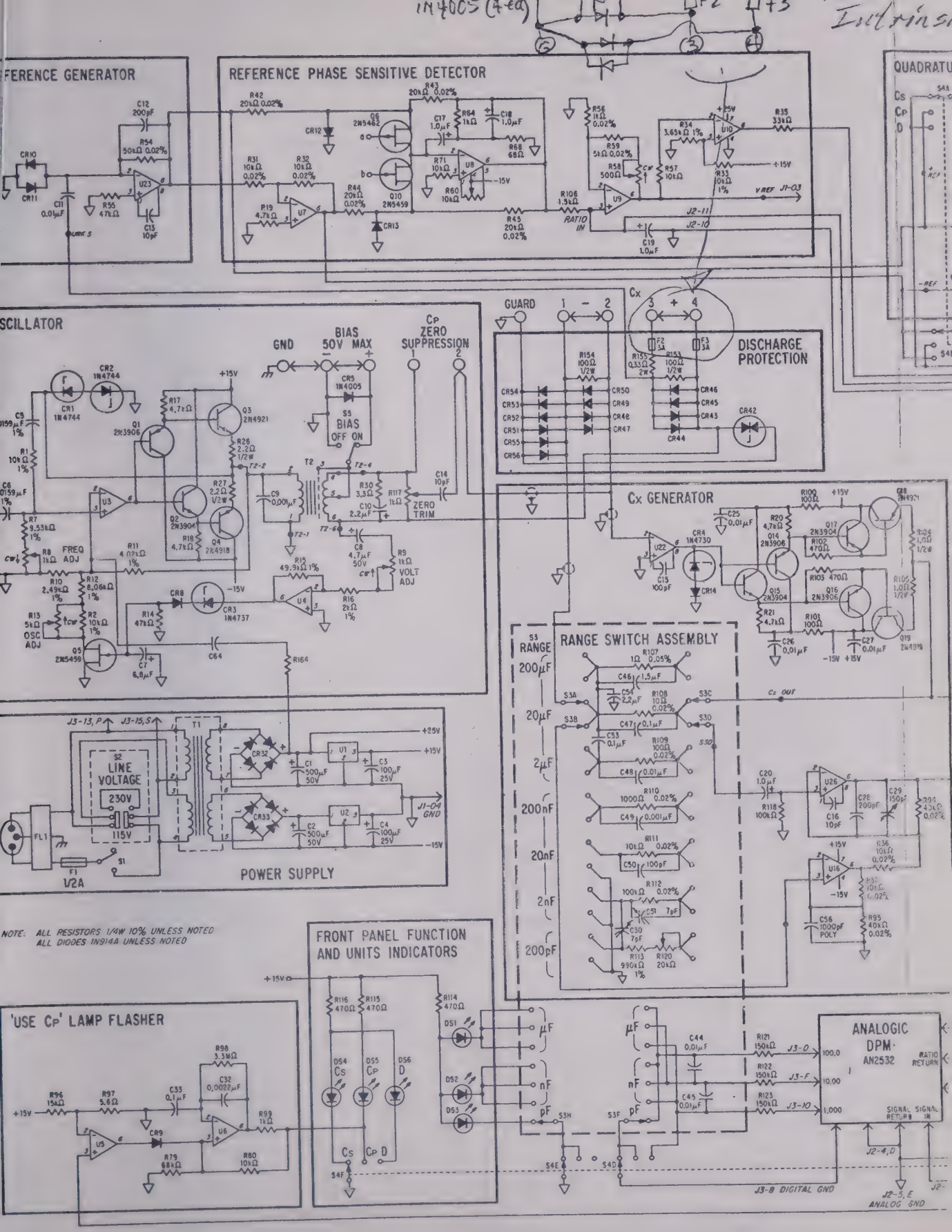

Figure 5-4. Model 275 Digital Capacitance Meter Sch

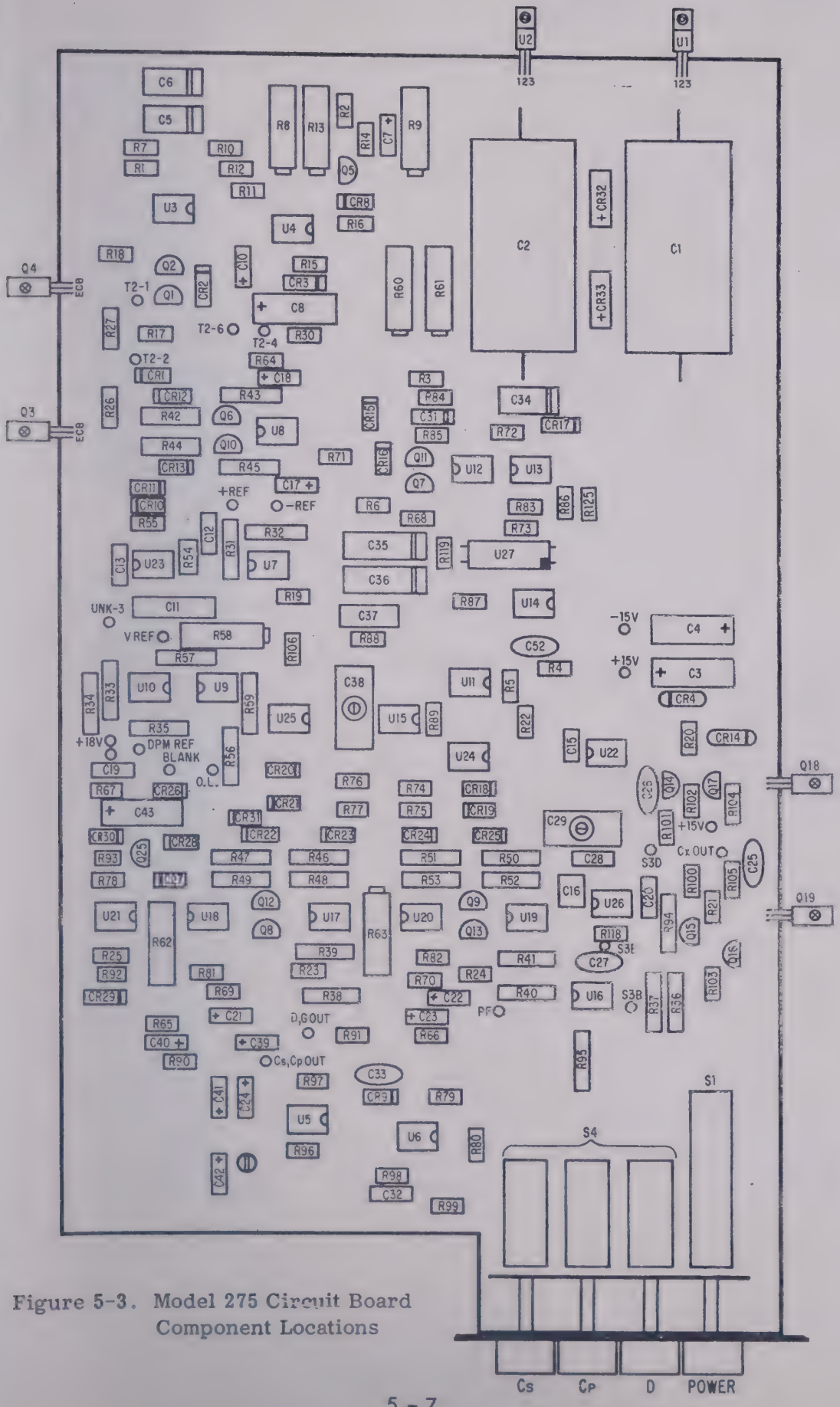

Figure 5-3. Model 275 Circuit Board Component Locations

CAUTION!

When making two terminal measurements, terminals 1 and 2 must be connected together and terminals 3 and 4 must also be connected together. The unknown must be connected across terminals 2 and 3.

Failure to make the above connections will result in incorrect readings from your instrument.

Part No. 23141

Electro Scientific Industries, Inc.

13900 NW Science Park Drive
Portland, Oregon 97229
Phone (503) 641-4141
Telex 36-0273

WARRANTY OF QUALITY

Electro Scientific Industries, Inc. warrants its products to be free from defects in material and workmanship for the following periods:

1. Two years for components and instruments using passive circuitry. One year for repairs of out-of-warranty items.
2. One year for components and instruments using active circuitry (see ESI Metrology Catalog). Six months for repairs of out-of-warranty items.

During the in-warranty periods, we will service or, at our option, replace any device that fails in normal use to meet its published specifications. Batteries, tubes and relays that have given normal service are excepted.

Would you like more information?

ESI technical publications are listed on the back of this page. If you would like any of these, simply check the appropriate box and fill in your address below. Also, please add any comments you have concerning the instrument or instruction manual. We value your feedback to help us improve or correct our manuals.

Instrument Description: Model No. _____ Serial No. _____
(Please Print)

Name _____ Title _____

Department _____ Mail Stop _____

Company _____

Address _____

City _____ State _____ Zip Code _____

Comments or corrections _____

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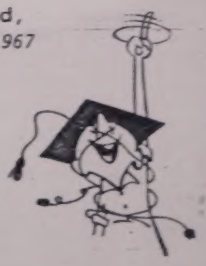
☐ TA6 The Accuracy of Series and Parallel Connections of Four-Terminal Resistors, *Jack C. Riley, April 1965*

☐ TA8 AC Measurements Using Ratio Techniques, *Jack C. Riley, May 1965*

☐ TA9 Strength for the Weak Spot in DC Potentiometry, *George D. Vincent and M. L. Roberts, October 1965*

☐ TA14 The Advantages of a Ten Kilohm Transportable Resistance Standard, *Robert M. Pailthorp, September 1967*



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☐ TA17 Experimental Verification of the Five-Terminal, Ten-Kilohm Resistor as a Device for Dissemination of the Ohm, *R. M. Pailthorp and George Vincent, December 1968*

☐ TA22A Laser Resistance Trimming from the Measurement Point of View, *Arthur G. Albin and Edward J. Swenson, June 1971*

☐ TA23 Precision Measurement of Resistor Networks, *Robert M. Pailthorp and Jack C. Riley, June 1971*

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